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The Influence of the Shallow Water Internal Wave Field
on the Properties of Acoustic Signals

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LONG-TERM GOAL

Quantitatively relate the temporal and spatial properties of shallow water acoustic signals to the physical processes that cause the temporal and spatial variability of the propagation channel. Address internal waves, tides, surface gravity wavefields and the heterogeneous ocean bottom/subbottom.

OBJECTIVES

Increase the understanding of the physics of broadband acoustic signal propagation through the random shallow water waveguide.

APPROACH

This research is focused on the analysis of portions of a data set obtained during an interdisciplinary oceanographic and ocean acoustics experiment (SWARM95). The experiment's objective was to increase the basic understanding of the physics of acoustic signal propagation through slope/shelf internal wave fields. The experiment required extensive physical oceanographic measurements to quantify the generation, propagation and decay of those internal wave fields. It was conducted on the New Jersey Shelf during the summer of 1995. The acoustic propagation path was placed on the NSF Ocean Drilling Program Seismic Line 1003. An extensive ONR/NSF geologic and geophysical data set has been developed for this line and is being used to include the effects of the heterogeneous bottom on the acoustic signals. Two acoustics sources (224 Hz and 400 Hz) were place at a distance of about 37 and 42 km from two vertical receiving arrays. Numerous thermistor arrays, temperature pods and bottom moored ADCP's were placed to monitor the properties of the water column.

WORK COMPLETED

The FY98's effort was focused on: 1) using high frequency acoustic flow visualization data digitized during FY97 to track the internal wave displacement of scattering horizons detected during the 22 day SWARM95 experiment; 2) providing sections of the tracked data to colleagues who used the data to perturb the measured range dependent sound speed structure at internal wave scales and 3) start the comparison of the temporal variability of the internal wave fields to the temporal dependent acoustic signal properties measured during the SWARM95 experiment.

RESULTS

The primary focus of the experiment was to measure the statistical and deterministic properties of the shelf internal wave field and relate those properties to the coherence, range dependent scintillation index and time fluctuation properties of the acoustic signals.

The tracked acoustic flow visualization data are being used to perturb the range dependent sound speed field interpolated from tow-yo CTD data taken along the acoustic propagation track. Broadband acoustic signals numerically propagated through this sound speed profile are being compared to the measured acoustic data (Finette (modeling) and Pasewark (data analysis)). Initial comparisons indicate that acoustic signal fluctuations appear to be related to the proximity of internal wave packets to the acoustic source. These observations appear to support some of the analytical predictions of Duda and Preisig. Analysis of the data continues.

IMPACT/APPLICATIONS

Results will permit the prediction of ASW system performance in shallow water propagation channels randomized by internal wave fields.

TRANSITIONS

Presentations to ONR and Naval Systems Laboratories. Direct impact on NRL Acoustic Communications research efforts.

RELATED PROJECTS

This research effort is a collaborative effort between Dr. James Lynch and associates from the Woods Hole Oceanographic Institution; Dr. John Apel, Ocean Associates Inc.; Dr. Mohsen Badiey, The University of Delaware; Dr. C. S. Chiu, the NPGS; and scientists at the Naval Research Laboratory. Results reported represent the efforts of several members of this team of scientists. The research effort is supported by ONR.

REFERENCES

Duda, T.F. and Preisig, J. C., 1998, submitted to IEEE Journal of Oceanic Engineering, Acoustic Effects of Moving Coastal Solitary Wave Packets.

PUBLICATIONS

Apel, J.R., Finette, S. Orr, M. H. and Lynch, J. F., 1998, submitted to JGR; in review, "The "Dnoidal" Model for Internal Solitons and Tides on the Continental Shelf"

Pasewark, B.H., Wolf, S.N., Orr, M. H. and Lynch, J. H., 1998, Fluctuations in acoustic propagation seen in the SWARM 95 experiment, J. Acoust. Soc. Am., 104, No 3, Pt 2, pg. 1765.